

May 2001 Highlights of the Pulsed Power Inertial Confinement Fusion Program

Nested wire arrays on Z produce ~200-TW x-ray pulses in a direction perpendicular to the array axis. Experiments in which nested tungsten arrays collide with a dynamic hohlraum have produced 13-TW axial x-ray pulses. We are modeling these experiments with a 2D radiation-magneto-hydrodynamics code, assuming the two arrays are plasma shells with initial temperatures of 1-eV. The dynamic (imploding) hohlraum includes an on-axis cylinder of CH₂ foam and an on-axis radiation exit hole (REH) in the anode. Radiation also exits through a hole perpendicular to the pinch (i.e., off axis). Our simulations are in qualitative agreement with the experiments and show that, when the wire plasma collides with the foam, a shock heats the foam, producing an on-axis “1st-strike” power. The reflection of the shock off the axis generates the on- and off-axis stagnation power (see Figs. 1 and 2). The simulations also show that ablation of the foam affects the character of the on- and off-axis power pulses.

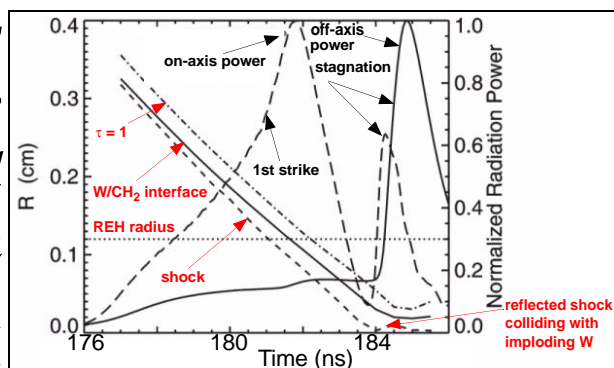


Fig. 1. Location of W/CH₂ interface, peak specific intensity surface (just behind shock front), and $\tau = 1$ optical depth surface. Ablated foam is snowplowed by the W plasma until a shock forms that moves faster than the W/CH₂ interface. On-axis 1st-strike power saturates when W reaches the REH radius. Peak off-axis power occurs after collision between reflected shock and W.

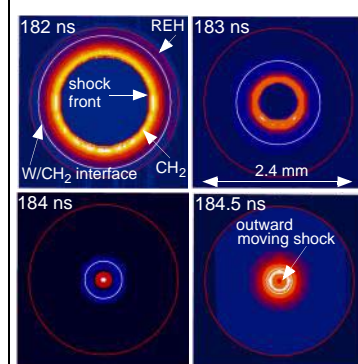


Fig. 2. Synthetic x-ray images from output of 2D simulation shown in Fig. 1. Each image shows view that would be seen by an on-axis x-ray pinhole diagnostic located a large distance from the radiation exit hole.

We had 16 Z shots. Thirteen were in the z-pinch mode: 2 with nested tungsten (W) arrays and an on-axis foam cylinder to determine the up/down angular dependence of an x-ray source for LANL weapon physics experiments, 4 with nested titanium arrays to obtain porous material data, a current scaling repeat of shot 51, 3 with a z-pinch-driven hohlraum for backlighter development, and 3 with TPX foam to study changes in Ti K-shell output for the Defense Threat Reduction Agency (DTRA). Three shots used the isentropic compression experiment method with Z in a short-circuit mode: 2 for the equation of state of an explosive with LLNL and 1 with the Atomic Weapons Establishment to obtain data on lead and a lead-antimony alloy. The DTRA shots included ride-along experiments with material samples from Argonne National Labs, an LLNL accretion diagnostic, and noise and electron evaluations.

At the January 31- February 2 review of the High Energy Density Physics (HEDP) program of the National Nuclear Security Agency (NNSA)/Defense Programs (DP), we presented a proposal to refurbish Z. This refurbishment, termed “ZR,” would refresh the aging 15-year-old equipment that now limits the number of shots and the data precision and would upgrade the current capability from 20 to 26 MA. The upgrade in current would create new opportunities for stockpile stewardship, such as higher-energy radiation sources for the Nuclear Survivability Campaign and higher pressures for the Dynamic Material Properties Campaign. The HEDP review committee recommended that the ZR proposal be assessed for possible inclusion in the HEDP baseline program. Accordingly, we are preparing for a June 25-26 meeting to evaluate the mission need for ZR. A panel composed of members from LANL, LLNL, DTRA, NRL, the Laboratory for Laser Energetics at the Univ. of Rochester, and NNSA will recommend whether ZR should be included in the HEDP baseline and the outyear DP budget.

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